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ELECTRICITY DEPARTMENT.

EXTENSION PROPOSALS.

Power Station Extensions 1915-16.

Electricity Offices,
February 5, 1915.

The Riverside Power Station, opened in April 1913, was designed to accommodate a total plant capacity of 14,000 kilowatts. In the first instance two 2,000 K.W. turbo-generators and four boilers, extra high-tension switchgear for the control of these two generators and four out-going feeders, and auxiliary machinery in the station, low-tension switchgear, coal storage and coal handling plant, pumps, steam and water pipework, etc., were installed.

The recent additions comprise two 5,000 K.W. turbo-generators, four boilers, additional extra high-tension switchgear for generators and two feeders, another large circulating water pump, pipework, etc. Thus bringing up the total plant installed to 14,000 K.W.

The design of the power house buildings is such that they can be extended to the full extent of the property the galvanised sheet iron end walls at the end opposite the river are arranged as temporary ones so that they can be removed and placed at the end of the next extension of the buildings. In the ordinary course of events the new buildings will therefore form an extension of the existing ones.

The supply of electricity is now, and will for a few years more, be generated at both Fearon Road and Riverside stations, and the programme which is being followed in accordance with the original scheme is that spare plant is not held at both stations, but such a reserve as will allow either station to act as a reserve for the other; in other words, under normal conditions if one of the larger sets were out of commission at Riverside, Fearon Road Station would furnish the reserve or spare plant, and vice versa. (This is assuming that the second 5,000 K.W. set at Riverside is installed). As time goes on and the Fearon Road Station plant is removed, to make room for switchgear and transforming apparatus, that station will naturally cease to be able to act as Riverside reserve, consequently the latter will then have to contain its own reserve plant.

To more clearly indicate the present need for further large extensions the maximum loads for the past ten years are set out, from which figures it may be seen how, as the undertaking increases in extent the yearly increase of the maximum load leaps up by larger bounds. Whereas in former years the annual increases were in hundreds now they are in thousands, and so these yearly growths will continue on a larger scale than ever before, always presupposing that the demand for electricity in Shanghai continues to grow. There seems no reason to expect that it will not. Shanghai follows the law of other large cities in respect of its electricity requirements, in fact it rather goes beyond many in its pace, therefore is there the more reason to look well ahead and prepare to meet them in good time.

Annual Increase in Demand.

Year	*Kilowatts*	*Increase*	
1905	1,090		
1906	1,411	321	
1907	1,-30	219	
1908	2,500	870	
1909	3,100	600	
1910	3,240	140	Metal lamps
1911	4 0 7	787	introduced.
1912	6.0 0	1,993	
1913	8,100	2,100	
1914	11,600	3,500	
1915 (estimated)	16,000	4,600	
1916	21,000	5,000	
1917	25,000	4,000	

The estimated loads for 1915, 1916 and 1917 are in my opinion conservative, between 1916 and 1917 it will be noted the increase shewn is only 4,000 kilowatts; it is quite probable that it will be higher following the lines of former years, but to avoid any suggestion of exaggeration the years 1916-1917 is purposely shown with a smaller increase. Even so, the 1917 demand will reach 25,000 kilowatts. It is, however, the requirements of 1916 which have to be considered. The expected load is 21,000 kilowatts to meet which there is a plant capacity in the two stations (leaving out for the moment the direct current traction plant for the provision of 900 kilowatts).

Fearon Road	4,400
Riverside	14,000
	18,400 K.W.

The list above gives the maximum load 1916 as 21,000 so taking off roughly 1,000 kilowatts for traction it leaves a 20,000-kilowatt load to meet which there is a *total installed plant* of only 18,400 kilowatts, but if due allowance for reserve plant is made which must be taken as equal to one of the largest units being out of use, i.e., 5,000 K.W. then the plant is only equal to supplying 13,000 K.W. or 7,000 K.W. short. It will thus be seen how imperative it becomes to make provision for 1916 with as little delay as possible. It will also be noticed that quite irrespective of the supply to the French Company extensions on a large scale are necessary. A point to be borne in mind is the necessity of taking out some of the boilers at Fearon Road and also the two 600 K.W. Ferranti steam-generators to make room for additional extra-high tension switchgear and step-down transformers, which will reduce the Fearon Road help by 1,200 K.W. and increase the demand at Riverside to the same extent.

The proposals for meeting the demands for the next few years, calculated to yield the most economical results and call for the lowest capital expenditure, are the provision of two 10,000 K.W. turbo-generators and eight boilers, together with all necessary switchgear, auxiliary machinery and apparatus, coal handling plant, underground cables, new buildings, pump house, etc. For the purpose of this Report it does not appear necessary to detail the proposals beyond shewing how the proposed extension will place the undertaking in a position to meet demands up to the end of 1917. Fearon Road will, as before mentioned, then be less by 1,200 K.W. alternating

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current plant, reducing it from 4,400 to 3,200 K.W. The installed plant capacity of the two generating stations will then be :—

Fearon Road		3,200 K.W.
Riverside		
2 sets @ 2,000=	4,000	
2 ,, @ 5,000=	10,000	
2 ,, @ 10,000=	20,000	
		34,000
		37,200 K.W.
Less 10,000 K.W. set in reserve. or its equivalent in smaller machines		10,000
		27,200 K.W.
Useful plant capacity	27,200	
Estimated Load (excluding traction	24,000	
Surplus	3,200 K.W.	

From the foregoing it would seem conclusive that immediate extensions become necessary without reference to the French Company supply. The acquisition of that company's load and the extra plant for providing it will therefore really amount to a comparative trifle in relation to our own additions.

If the extension scheme is approved, orders for the new plant, buildings, etc , should be placed as early as possible if the station is to be ready to commence running in the latter part, of 1916. Delays of one sort or another always do occur, but even if manufacturers of the various sections of the plant are able to offer good deliveries and if such deliveries are actually effected, even then there will only be just time to complete the job. The Committee is asked to realise that this scheme embraces a much bigger extension than the first section of the Riverside Station, being in the relation of 20,000 to 14,000 K.W. The amount of detail to settle, plans and specifications to prepare, selection of tenders and final adjustments after selection occupy much time, after which comes the manufacture, shipment and erection. These obvious references are made in order to emphasize the urgent need of getting ahead with the scheme. The next report will deal with the estimate of cost.

T. H. U. Aldridge,
Electrical Engineer.

Capital Expenditure 1915-16.

Electricity Offices,
March 4, 1915.

Attached is set out in detail the estimated cost of providing an additional 20,000 kilowatt plant comprising new steel buildings, turbines, generators, switchgear, boilers, chimneys, pumps, etc., and also trunk mains between Riverside and Fearon Road, together with the necessary excavations, foundations and concrete buildings. This additional plant will bring the total plant capacity of the Riverside Power Station to 34,000 kilowatts.

Two years ago, when the recent 10,000 K.W. extensions at Riverside were planned, provision was made that future trunk feeders between that Station and Fearon Road should work at a pressure of 11,000 volts, instead of 6,600, in order to secure cable economy in future extensions. The output from Riverside did not at once justify the expense of extra switchgear at both stations and also step-up and step-down transformers for changing the pressure, therefore the two recently laid trunk cables, made for 11,000 volt working, are working at 6,600 volts. At this pressure the full carrying capacity of the cables cannot be taken advantage of, although, as pre-arranged, they are sufficient to deal with the present load. The time is approaching, however, when it becomes necessary, in order to obtain the full benefit of these cables, to raise the pressure to 11,000 which will increase the carrying capacity. For this purpose transformers and switchgear are required for which provision is made in these capital estimates. This particular section of the extensions should be regarded separately from the larger and principal scheme as it is in reality the completion of the first Riverside Station ; it completes the proportion of underground cables for transmitting the 14,000 K.W. output for which the existing Station is designed.

It will be noted that extra switchgear and also transformers are to be installed at Fearon Road Station. This is in accordance with the original plan of making the Station become in time purely a distributing as distinct from a generating station. The special yearly depreciation which is being allowed for reduction of the plant value applies to the generating machinery and some of the older switchgear only, not to the new switchgear and cables installed last year, nor to the new apparatus to be installed under the scheme forming the subject of this Report.

The 20,000 K.W. extension scheme should provide sufficient plant for a few more years, but in the light of past experience it seems inadvisable to make a statement as to how long it is likely to be before another extension becomes necessary. Extensions at Riverside, however, are comparatively straightforward in that the existing station and the proposed extensions follow the original ideas which were held when the property was acquired. It is true that the recent and proposed extensions are on a scale of greater magnitude than originally contemplated, but this feature is the natural outcome of the larger demand for electricity in Shanghai.

There is one detail to which the Committee's particular attention is called, viz., the relative merits of 11,000 and 33,000 volt transmission by underground trunk cables, between Riverside and Fearon Stations. Since 11,000 volt transmission was decided upon two years ago, developments have recently been taking place, and ideas changing. with regard to the pressure of transmission by underground cables. There seems to be a tendency towards a much higher pressure for trunk transmission work between the large generating station and the central distributing station, whilst limiting distribution from the latter to pressures of 6.600 or 11,000 as more or less standard, i.e., for urban distribution such as Shanghai requires. Modern practice in power house design is to divide the plant up on the "unit" system so that each section may operate independently if required, although under normal conditions the station operates as a whole. The existing Riverside Station and the proposed extension may be likened to two side by side stations with separate boiler house plant and switchgear for the turbo-generators and feeders in each section, although actually they will be both electrically connected together and feeding into the common cable system, and the boiler-house pipework will likewise be so coupled that each boiler-house can supply either separately or collectively. A further development of this practice may be found in the tendency to increase the size or rather the kilowatt capacity of trunk cables by operating a few cables at a higher pressure rather than a larger number at lower pressure. Under certain conditions it appears more economical, for the purpose of transmitting a very large output from generating station, to distributing station, to go up to higher pressures and limit the amount of cable. The problem resolves itself into the question of where the saving in copper and lead is offset by the higher cost of insulation of the cables, and transformers. There is, of course, another consideration besides saving in cost. It may be suggested that by the employment of few cables transmitting very large electrical loads the breakdown of one will throw undue strain upon the others, or even curtail the general supply of electricity by the amount which the cable was previously carrying. This is true, but equally it may be argued that if a very large generator breaks down which is feeding into a number of cables each carrying relatively smaller loads, then these cables are of no particular use at this time because there is no generator from which the cables may be fed. As generating stations become larger in plant capacity, and contain very large units, it is recognised that for continuity of supply to the public a certain amount of reserve machinery must be carried. Why not then regard switchgear, turbine-generator, boilers, and cable, all as one complete unit, regard the cable as part of a generator for the purpose of the reserve plant required ? In practice the breakdown of a trunk cable would not necessarily mean that the boilers or generators feeding it would be useless for other purposes, on the contrary they would continue the supply through other feeders. Conversely, the breakdown of a generator would still leave the trunk cable available for transmitting current from the remaining generators in the Station.

The foregoing explanation has been indulged in because the selection of the pressure for the future trunk cables is a very important one in its bearing upon the future lay-out of Riverside and Fearon Road Stations. No little interest at the moment centres round Manchester's municipal activities. The Manchester electricity department is proposing to erect a new super-station designed to ultimately contain 160,000 kilowatts of generating plant. The site selected for the power station is 5 miles from the distributing station which is more or less in the centre of the area of supply. At the new station the first two units are to be each of 15,000 K.W., to be followed as necessity demands by two more of the same size. These will subsequently be followed by units of 25,000 K.W. each. The point of interest for Shanghai is that for the delivery of 30,000 K.W. (that is the plant capacity of the first instalment of plant), only two trunk cables will be employed between the generating and distributing stations, working at 33,000 volts pressure. Geographically, the Manchester and Shanghai schemes are not unlike, in both places a very large load has to be transferred from one point to another, in both places the distance is 5 miles. It is not concluded, without closer examination of the subject, that a 33,000 volt transmission scheme for Shanghai will be the best, but at the same time calculations and investigations, so far as they have gone, certainly tend towards it.

T. H. U. Aldridge,
Electrical Engineer.

Riverside Power Station Extension 1915-16 together with trunk mains between Riverside and Fearon Road Stations, step-up and step-down transformers at both stations and switchgear for same.

2.—10,000 K.W. (12,500 K.V.A.) turbo-alternators with condensers including air and discharge pumps but not circulating water pumps	£ 50,000
8.—Water-tube boilers, marine type complete with feed water heaters, superheaters, mechanical stokers, fittings complete. Each boiler to evaporate 40,000-lb. water per hour	
4.—Steel chimneys—one to each pair of boilers complete with motor-driven fans, two to each chimney	50,000
2.—Electrically-driven turbine feed pumps	600
1.—Steam-driven feed pump	270
Boiler-house steam, water, exhaust and blow-down pipework, water storage tank, hotwell and Lea recorders	6,000
Coal-conveying plant for (1) new boiler-house, and (2) transporter from wharf to coal store	5,500
Extra high-tension switchgear for the control of the two—10,000 K.W. generators, feeders, step-up transformers and station transformers.	4,500
Low-tension ironclad switchgear for control of station auxiliaries	400
3.—Vertical electrically-driven centrifugal pumps for condenser circulating water, small pumps for storage tank and hotwell, with cast iron pipework, steel girders, ladders and gratings	5,000
3.—Sets mechanical water filters	360
2.—Wet-air filters for filtration of air supply to the 10,000 K.W. generators, motor-driven pumps and necessary water piping	450
E.H.T. connecting cables between generators, transformers and switchgear	2,000
Low-tension cables for connecting auxiliaries	500
7.—Single-phase step-up transformers—one spare—each of 4,000 K.W. capacity at Riverside.	14,000
7.—As above step-down transformers at Fearon Road	14,000
1.—Set of re-actances for use between the existing and the extension switchgear	1,000
Structural steelwork and galvanised iron sheeting for turbine room and boiler-house, and overhead coal bunkers to hold 1,000 tons coal also structural steelwork for carrying chimneys and motor-driven draught fans	10,000
Extra high-tension trunk feeders to connect Riverside and Fearon Road.	22,000
	186,580
Add Freight, Insurance, Commission 20 per cent.	37,316
	£223,896
Local Expenditure :—	Tls.
Excavation and concrete foundations, New pump-house, switch-house, fire-bricks, tiles, and sundry work by the Public Works Department, and cable laying	120,000
Total estimated cost of Riverside Extensions :—	
£223,896 at 2/3=	1,990,186
Local	120,000
	Tls. 2,110,186

Estimated cost to complete the existing Riverside plant by raising two trunk feeders to a pressure of 11,000 volts.

4.—2,670 K.W.—one spare—single-phase step-up transformers, 6,600/11,000 volts for use in connexion with the existing two .2—11,000 volt underground cables between Riverside and Fearon Road now being worked at 6,600 volts.	
4.—Step-down transformers as above for use at Fearon Road Station	£ 10,680
Switchgear at Riverside (11,000 volts) for control of feeder transformers and feeder cables	1,200
Switchgear at Fearon Road for control of the two .2—11,000 volt cables from Riverside, and new trunk feeder cables to be provided, also two out-going 11,000 volt feeders	2,000
Connecting cable for above	600
	£14,480
Add Freight, Insurance, Commission Duty, etc.	3,136
	£17,616
£17,616 at 2/3 = Tls. 156,586	
Local expenditure constructing switchgear floor at Fearon Road, transformer cubicles, cable ducts, etc. Tls. 10,000	
Total estimated cost	Tls. 156,586
	10,000
	Tls. 166,586
	Tls.
Cost Riverside extension	2,110,186
Cost Riverside—Fearon Road trunk connexions (Raising pressure from 6,600 to 11,000 volts) as per 1913 scheme, and providing switchgear at Fearon Road for same and also for additional in-coming trunk cables and outgoing feeder cables	166,586
Grand Total Tls.	2,276,772

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